SNOW MELTING ROBOT

Snow-Melting Robot:
An autonomous robot to enhance safety on snowy walkways by distributing salt to melt snow, aiding in pedestrian mobility.

Uses:
•**Residential:** Maintains clear pathways around homes, preventing slips and falls.
•**Commercial:** Keeps parking lots, sidewalks, and outdoor areas accessible for customers ar employees.
•**Industrial:** Ensures safe operation in outdoor industrial settings by preventing ice accumulation on machinery and walkways.

Challenges:
- Uneven snow accumulation requires a varied salt distribution
- The need for outdoor navigation with accurate localization and obstacle avoidance

POWER

Component Power Requirements:

Computation: NVIDIA Jetson Board – 10-15W (for SLAM, image processing, and sensor fusion tasks).

LiDAR (Livox Mid 360) – 12W (for mapping, navigation, and obstacle detection).

Depth Sensor (Intel RealSense 435) – 2W (to measure snow depth).

GPS (BU353n) – 1W (for outdoor localization).

Temperature & Humidity Sensor (BME280) – 0.01W (minimal power draw for environmental monitoring).

IMU (VN1100) – 0.18W (for orientation and balance).

Camera (IMX219-160 8 MP) – 0.5W (for navigation and obstacle detection).

Salt Dispenser Motor (for distributing salt) – ~5W (estimated for periodic operation).

Drive Motors (4 Motors at 20W each): 80W total. This assumes each motor requires around 20W to handle the additional force needed for movement on snow.

Total Estimated Power Usage:

Idle Mode (minimum power, limited actuator/sensor usage): ~35W.

Active Mode (full navigation and SLAM): 115W.

Battery Specifications:

Battery Type: Lithium-ion 24V, 20Ah battery pack.

Capacity: 480Wh (24V * 20Ah).

Idle Mode:
Operating Time = 480/35 = 13.7 hr

Active Mode:
Operating Time = 480/115 = 4.17 hr

SENSORS

CAMERA:

Camera is necessary for capturing data which is essential for navigation and obstacle avoidance tasks. It also enhances SLAM by recognizing environmental features

LIDAR:

LIDAR is used to IR range information that is crucial for SLAM. LIDAR is used for mapping the environment. First the environment is mapped then the LIDAR provides distance information for Navigation (Localization) as well as obstacle avoidance.

TEMPERATURE SENSOR:

Temperature Sensors are needed to calculate the temperature the robot is operating in. The information maybe helpful in determining the total amount of salt to be applied

DEPTH SENSOR:

Depth Sensors are needed to calculate the snow depths, which will be uneven in the outdoors. Based on this information, we will distribute our salt accordingly.

GPS:

GPS sensors facilitates outdoor localization and path tracking.

NAVIGATION

SLAM:

Implementation of SLAM will be integrated with LIDAR sensor in order to map the environment. The robot is meant to operate mostly outdoors, therefore it relies on GPS, LiDAR and Camera for path planning and obstacle avoidance.

ROS2:

ROS2 would be needed to run these navigation tasks while computing a combined navigation stack, mapping and localization from LiDAR with quick dynamic updates from object detection to register destinations using camera. We also need ROS2 to get inputs from other sensors like Temperature and Humidity sensor and act accordingly.

ROS 2™

IMU:

We'll be using IMU's that have accelerometer and gyroscope. We need an accelerometer to improve the accuracy of SLAM's localization accuracy. Gyroscope is an important sensor as it calculate orientation angles with which we can make the robot self-balancing as the robot will be exposed to many imperfect terrains.

SOFTWARE

The NVIDIA Jetson onboard processor manages real-time SLAM, image processing, and navigation, seamlessly integrating data from the LiDAR, camera, GPS, IMU, and depth sensor to enable autonomous operation. Through sensor fusion, it combines these inputs to create a unified environmental model, facilitating timely obstacle avoidance, dynamic path updates, and precise salt distribution. The system operates on ROS2, allowing smooth integration and control across all sensors and computational tasks.